Learning and enactive interfaces

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Enactive Learning is a relatively new expression, used in enactive community, to desinate the process of learning by doing. In human sciences, several theories/models are confronted concerning the learning process. Usually, three main theories of learning are distinguished:

- Behaviourism, which is mainly based on the model of reinforcement of stimuli – response.
- Cognitivism, related to computational theory of mind [→ Computational paradigm], which is mainly concerned with information processing and the perception – decision - action schema.
- Constructivism [→ Constructivism], related to enactive cognitive sciences [→ Enactive cognitive sciences_ 1&2] - which is understood here as an umbrella term (from Vygotsky and Piaget to Varela).

Within the constructivist approach, one can quote for example:

- Bandura's social cognitive theory [Bandura, 1986] and social learning theory which put an emphasis on two types of learning: observational learning, self-regulation and learning througt direct experience.
- Bruner's [Bruner, 1966] approach [→ Enactive knowledge] of learning progress from sensory (enactive), to concrete (iconic), to abstract (symbolic) knowledge.

Nowadays, many works refer to the use of computer systems in learning activities, such as Technologically Enhanced Learning (TEL) [kaleidoscope 2004-2007].

Especially, lots of research and developments are performed regarding databases, digital libraries, and didactic tools in the context of formal sciences learning (mathematics, geometry, etc.), etc. Conversely, despite their potential interest, only a few new uses are emerging from the development of interactive simulation and virtual reality systems. Among the most important are:

- Case 1: the use of computer to learn manuals tasks. It appears that there are difficulties to overcome to implement them in e-learning or Technologically Enhanced Learning TEL systems;
- Case 2: more recently, the use of multimodal human-computer interfaces to sensorialize (visualize, sonify, haptizise) the learning process of domains that are traditionally taught theoretically though formal representation (geometry, nanophysics, chemistry, etc). Such learning process may highly benefit from being supported by sensory representations allowing an active investment of the learner.

Case 1

Regarding manual tasks (driving a car, playing the violin, skiing, handwriting, etc.), considering that they are typical enactive examples, their learning can be called enactive learning. For these tasks, mental or abstract rehearsals based on only symbolic or iconic representations are trivially inefficient; a direct (enactive) training is absolutely necessary. However, to help this direct training, since the intructor's know-how cannot be made objective, learning necessitates instructors to mimic the task, find understandable metaphors, etc. As a consequence, reaching a stable learning requires a large number of trials/error cycles.

For the learning of such tasks, new systems such as real time interactive simulators or virtual reality platforms offer the unique opportunity to objectivise the manual process: replay of the instructor gesture, record and analyse the learner's performance, adapt the situation (the behaviour of the simulator) to the learning level, etc. A major question is, however, the possibility of a back-transfer from the virtual situation to the real one, on which the learner will really act after the learning process. This requires reaching the appropriate level of similarity between both situations, which leads to question the concept of the action fidelity [→ Action fidelity].

The case of the new instruments and systems that are based from the outset on computerized technologies, and of their learning, calls for a few specific remarks. In the continuation of the Leroy-Gourand anthropological approach [Leroy-Gourhan, 1964], one can note that in this case the same technological instrument serves both the enactive learning of the task, and the task itself after the learning. As an important feature, such instruments inherently offer the possibility discussed above of objectifying the learning process. Action fidelity is, indeed, no more a question.

Case 2

The use of enactive interfaces is today particularly promising regarding the sensorialisation of non-sensory based domains in order to support the learning process. Some examples (the list is not limitative) are: learning geometry through senses [Gouy-Pailler et al., 2007], and learning what nanophysics is through a simulator allowing an enactive interaction with simulated nano objects [Marchi et al., 2005]. However, a lot of work has still to be achieved to circumscribe exactly the gain of such training simulators for symbolic knowledge, and to develop efficient solutions adapted to the task to be learned, as exemplified in [Sreng et al, 2006].

Despite these difficulties, as a conclusion, improving learning of manual tasks, and moreover improving learning of non-manual knowledge, through enactive computer-based systems, such as those sketched by virtual reality systems, robotics, interactive simulation, including haptic devices and multisensory feedbacks, are two major promising aims with societal, scientific and technological implications.

References

[Bandura 1986] Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice-Hall; 1986.

[Bruner, 1966] Bruner, J. S. (1966) Toward a theory of instruction. Harvard University Press: Cambridge, MA.

[kaleidoscope 2004-2007] FP6: kaleidoscope Network of Excellence www.kaleidoscope.org

[Gouy-Pailler et al. 2007] Gouy-Pailler C. Zijp-Rouzier S. Vidal S. Chêne D. "Haptic Based Interface to Ease Visually Impaired Pupils - Inclusion in Geometry Lessons" in "Universal Access in Human-Computer Interaction. Applications and Services". Springer. Volume 4556/2007

[Leroy-Dourhan, 1964] A. Leroy-Gourhan. Le geste et la parole. Albin Michel Ed. 1964.

[Marchi 2005] F. Marchi. S. Marlière. D. Urma. J.L. Florens. J. Chevrier. C. Cadoz. A. Luciani, Interactive learning of nanophysics phenomena, mICTE Juin 2005, Barcelone (2005).

[Sreng, 2006] J. Sreng, A. Lécuyer, C. Mégard, C. Andriot, "Using Visual Cues of Contact to Improve Interactive Manipulation of Virtual Objects in Industrial Assembly/Maintenance Simulations", IEEE Transactions on Visualization and Computer Graphics. 2006.

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